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Dated 25 MAR 2002

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Request for grant of a patent

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05 MAR 2001

06MAR01 E611111-3 D02094
P01/7700 0.00-0105413.9

1.	Your reference	07 37717
2.	Patent application number	**0105413.9**
3.	Full name, address and post code of the or each applicant	Nokia Mobile Phones Limited Keilalahdentie 4 02150 Espoo Finland
	Patents ADP number	59119950004
	If the applicant is a corporate body, give the country/state of its incorporation	FI
4.	Title of the invention	ANTENNA
5.	Name of your agent	VENNER, SHIPLEY & CO
	"Address for service" in the United Kingdom to which all correspondence should be sent	20 LITTLE BRITAIN LONDON EC1A 7DH
	Patents ADP	1669004

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and the or each application number

Country	Priority application number	Date of filing

7. If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application

Number of earlier application	Date of Filing

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'YES' if:*
a) any applicant in 3. above is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body)

YES

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	5
Claim(s)	2
Abstract	1
Drawing(s)	3+3

10. If you are also filing any of the following state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	one
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents	0

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 5 March 2001

12. Name and daytime telephone number of person to contact in the United Kingdom

STUART GEARY
020 7600 4212

Antenna

Description

The present invention relates to an antenna.

Bluetooth is a short-range wireless networking system operating in the ISM 2.4GHz band. The development of Bluetooth has required designers of disparate electronic devices to include rf circuitry for the first time and, in the case of mobile phones, additional rf circuitry. This of course can lead to undesirable increases in the size of devices to accommodate the electronics and the antenna or antennas required.

According to the present invention, there is provided an antenna comprising an element formed from conductive patterns on a plurality of layers of a multilayer PCB, wherein the conductive patterns are in stacked relation and interconnected through the PCB.

Preferably, the element is located at the edge of the PCB. This reduces the amount of lossy PCB material in the vicinity of the antenna. Additionally or alternatively, the PCB may apertured adjacent to the element. This also reduces the amount of lossy PCB material in the vicinity of the antenna.

The present invention may be embodied in an inverted-F antenna comprising an F-shaped conductor pattern on a first layer of the PCB and an I-, L- or F-shaped conductor pattern on the or each other layer, wherein the or each I-shaped conductive pattern is substantially coextensive with the "upright" of the F-shaped conductor pattern.

Preferably, the or each I-, L- or F-shaped conductive pattern extends along the edge of the PCB.

Preferably, the PCB is apertured, e.g. by means of a slot, between the "upright" of the F-shaped conductive pattern and a ground plane area.

An antenna ground plane may be provided by a plurality of vias connecting ground plane regions on respective PCB layers.

An antenna according to the present invention may be employed in a mobile phone.

An embodiment of the present invention will now be described, by way of example, with reference the accompanying drawings, in which:-
Figure 1 is a block diagram of a mobile phone including an antenna according to the present invention;
Figure 2 illustrates the arrangement of an antenna according to the present invention on the main PCB of the mobile phone of Figure 1; and
Figure 3 is an exploded view of the antenna of Figure 2.

Referring to Figure 1, a mobile telephone comprises an antenna 1, an rf subsystem 2, a baseband DSP (digital signal processing) subsystem 3, an analogue audio subsystem 4, a loudspeaker 5, a microphone 6, a controller 7, a liquid crystal display 8, a keypad 9, memory 10, a battery 11, a power supply circuit 12, a Bluetooth transceiver 13 and a Bluetooth antenna 14.

The rf subsystem 2 contains if and rf circuits of the mobile telephone's transmitter and receiver and a frequency synthesizer for tuning the mobile telephone's transmitter and receiver. The antenna 1 is coupled to the rf subsystem 2 for the reception and transmission of radio waves.

The baseband DSP subsystem 3 is coupled to the rf subsystem 2 to receive baseband signals therefrom and for sending baseband modulation signals thereto. The baseband DSP subsystems 3 includes codec functions which are well-known in the art.

The analogue audio subsystem 4 is coupled to the baseband DSP subsystem 3 and receives demodulated audio therefrom. The analogue audio subsystem 4 amplifies the demodulated audio and applies it to the loudspeaker 5. Acoustic signals,

detected by the microphone 6, are pre-amplified by the analogue audio subsystem 4 and sent to the baseband DSP subsystem 4 for coding.

The controller 7 controls the operation of the mobile telephone. It is coupled to the rf subsystem 2 for supplying tuning instructions to the frequency synthesizer and to the baseband DSP subsystem for supplying control data and management data for transmission. The controller 7 operates according to a program stored in the memory 10. The memory 10 is shown separately from the controller 7. However, it may be integrated with the controller 7. A timer for triggering interrupts is also provided by the controller 7.

The display device 8 is connected to the controller 7 for receiving control data and the keypad 9 is connected to the controller 7 for supplying user input data signals thereto. Amongst other function, the display device displays the estimated extant life of the battery 11 by

The battery 11 is connected to the power supply circuit 12 which provides regulated power at the various voltages used by the components of the mobile telephone. The positive terminal of the battery 11 is connected to an analogue-to-digital converter (ADC) input of the controller 7.

The Bluetooth transceiver 13 is controlled by the controller 7 and sends and receives signals via the Bluetooth antenna 14.

Referring to Figure 2, the PCB 40 of the mobile phone has an upper end on which the loudspeaker 5 is mounted. The display 8 is mounted below the loudspeaker 5 and below the display is the keypad 9. The Bluetooth antenna 14 comprises an inverted-F antenna formed in a small strip-shaped region to the side of the keypad 9.

Referring also to Figure 3, the PCB 40 has first to eighth layers 40a, ..., 40h (shown with exaggerated thickness). The layers 40a, ... , 40h have respective ground plane areas 41a, ... , 41h. The ground planes 41a, ... , 41h are partially removed at the

edges of the layers 40a, ... , 40h. However, an F-shaped region 42 of conductor is left on the first layer 40a. The "upright" of the F-shaped region 42 runs along the very edge of the first layer 40a with the "arms" directed inwards towards the ground plane 41a. Only the upper "arm" actually joins the ground plane 41a.

On the second to eighth layers 40b, ... , 40h, an I-shaped region 43b, ... , 43h of conductor is left along the edge under the "upright" of the F-shaped region 42 and coextensive therewith. The eighth layer 40h may be double sided and also have an I-shaped region on its other side.

The fourth layer 40d includes the feed 46 to the antenna which extends to a point under the shorter "arm" of the F-shaped region 42.

The "upright" of the F-shaped region 42 and the I-shaped regions 43b, ... , 43h are connected by a plurality of vias 52. This unites these regions which collectively form the radiating element of the Bluetooth antenna 14. Similarly, the feed 46 is connected to the shorter "arm" of the F-shaped region 42 by a via 47. A row of vias 51 unites the edges of the ground plane areas 41a, ... , 41h, which are substantially parallel to the "upright" of the F-shaped region 42, to form a ground plane for the antenna.

In order to reduce losses, two slots 48, are cut through the full thickness of the PCB 40. The slots 48 are located so that they are between the "upright" of the F-shaped region 42 and the ground plane on the first layer 40a, and extend parallel to the "upright" of the F-shaped region 42.

It will be appreciated that many modifications may be made to the above-described embodiment. For example, the I-shaped regions could be replaced with L-shaped regions which match the "upright" and upper arm parts of the F-shaped region or further F-shaped regions.

The antenna may be formed using other multilayer PCB structures, for instance three double-sided PCB layers (i.e. copper on both faces) may form the second to

seventh layers of the antenna with single-sided PCB being used to form the first and eighth antenna layers.

Other forms of antenna, e.g. resonant dipoles, can be formed in a similar manner. Furthermore, multi-element antennas may be formed if directivity is a desirable characteristic. Additionally, a plurality of antennas by be formed on the same PCB or in the same way on different PCBs to provide path diversity, directivity or omni-directivity as desired.

Claims

1. An antenna comprising an element formed from conductive patterns on a plurality of layers of a multilayer PCB, wherein the conductive patterns are in stacked relation and interconnected through the PCB.

2. An antenna according to claim 1, wherein the element is located at the edge of the PCB.

3. An antenna according to claim 1 or 2, wherein the PCB is apertured adjacent to the element.

4. An inverted-F antenna according to claim 1, comprising an F-shaped conductor pattern on a first layer of the PCB and an I-, L- or F-shaped conductor pattern on the or each other layer, wherein the or each I-shaped conductive pattern is substantially coextensive with the "upright" of the F-shaped conductor pattern.

5. An antenna according to claim 4, wherein the or each I-, L- or F-shaped conductive pattern extends along the edge of the PCB.

6. An antenna according to claim 5, wherein the PCB is apertured between the "upright" of the F-shaped conductive pattern and a ground plane area.

7. An antenna according to claim 6, wherein the PCB has a slot between the "upright" of the F-shaped conductive pattern and a ground plane area.

8. An antenna according to any preceding claim, including an antenna ground plane comprising a plurality of vias connecting ground plane regions on respective PCB layers.

9. A mobile phone including an antenna according to any preceding claim.

10. An antenna substantially as hereinbefore described with reference to the accompanying drawings.

Abstract

Antenna

An antenna (14) is formed at the edge of a multilayer PCB (40). An element of the antenna consists of foil pattern elements on a plurality of layers of the PCB (40) connected by vias (52)

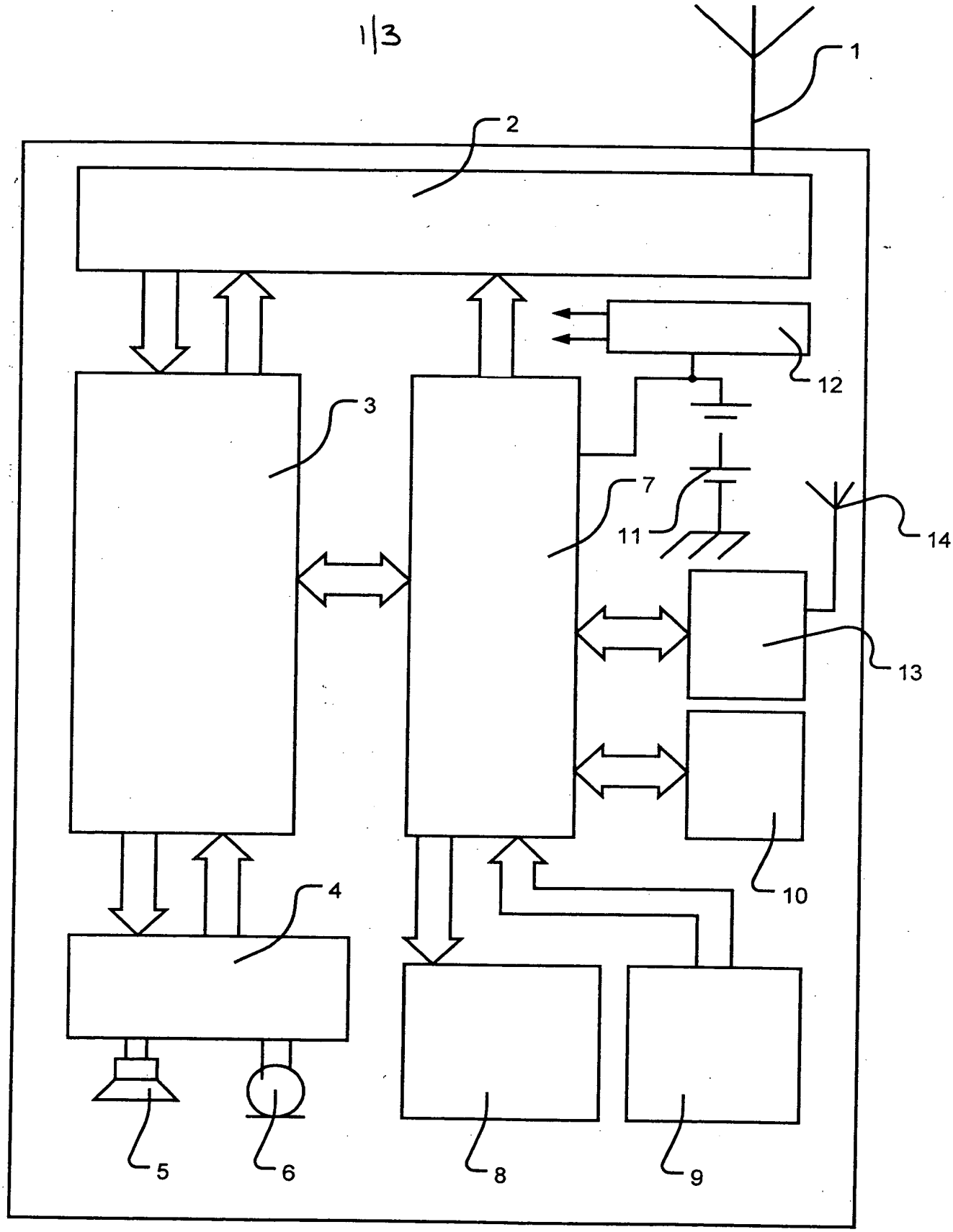

Figure 1

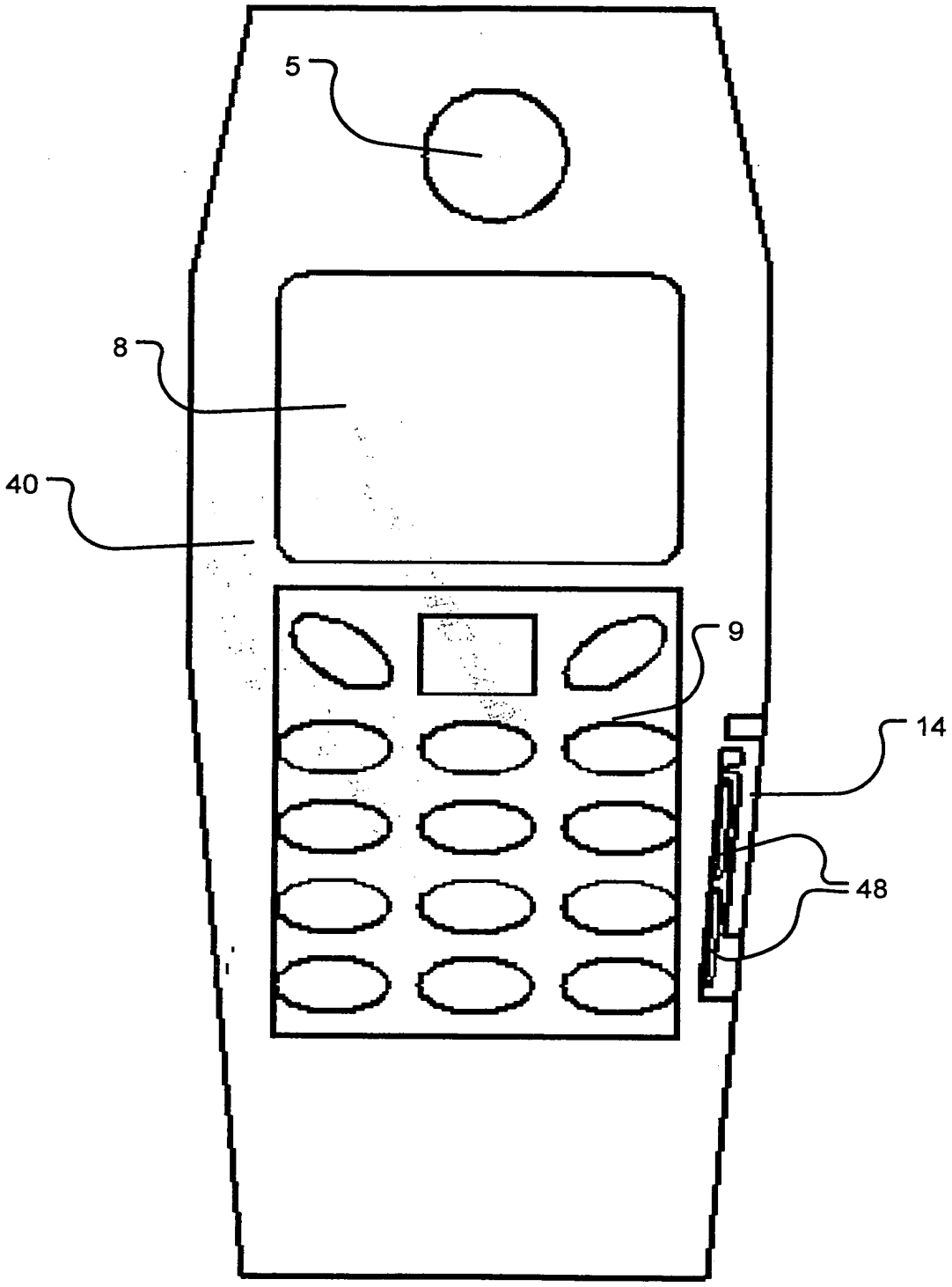

Figure 2

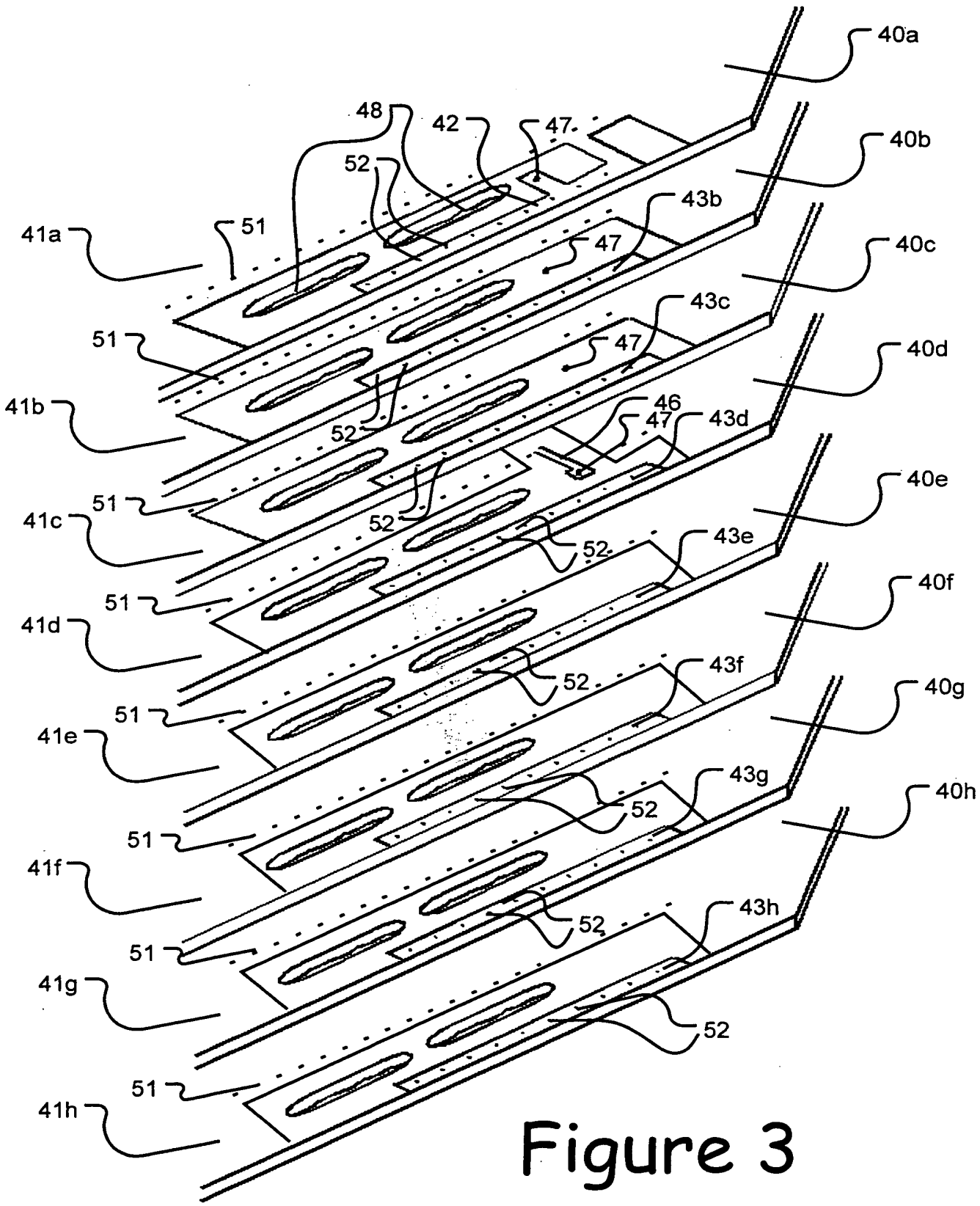
40a
40b
40c
40d
40e
40f
40g
40h
48
42
47
52
43b
41a
51
47
43c
51
47
41b
46
47
43d
52
40e
51
41c
52
52
43e
51
40f
41d
52
43f
51
40g
41e
43g
52
40h
51
41f
43h
52
51
41g
52
51
41h

Figure 3